FARA Dissemination Note

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Proceedings of the PARI Mechanization Cluster Meeting

At the Conference Room of the Agricultural Research Council of Nigeria (ARCN), Abuja, Nigeria

27th and 28th September 2019

This research cluster meeting was organized under the auspices of the Program of Accompanying Research for Agricultural Innovation (PARI) www.research4agrinnovation.org , a research program of Center for Development Research (ZEF), University of Bonn, Germany. PARI is supported with funding from BMZ. The logo of other partner organizations is appended

A. Background

The Program of Accompanying Research for Agricultural Innovation (PARI) is a research program of the Center for Development Research of the University of Bonn. The program is implemented in close partnership with Africa countries coordinated by FARA and other Universities in Germany. The PARI program has it root in the One World – No Hunger Initiative of the government of Germany. The central objective of PARI is to carry out research and identify investment opportunities in the agriculture sectors and rural areas of Africa with the aim of improving food security and creating employment and income opportunities. The current agenda of PARI entails the following research clusters:

1. Targeting investments in **innovations and framework conditions**
2. **Mechanization and skill development** for productivity growth, employment and value addition
3. **Digitalization** in agriculture, food and nutrition
4. Enhancing opportunities for the **youth** in the rural economy

The mechanization and skills development research cluster comprised of researchers from lead agricultural research institute from four Africa countries viz., Kenya (Kenya Agricultural and livestock research Institute [KALRO]; Nigeria (Agricultural Research Council of Nigeria [ARCN]; Benin (Institut National des Recherches Agricoles du **Bénin** [INRAB] and Mali (Institut d'Economie Rurale [IER]. The research is led by University of Hohenheim and FARA in close collaboration with ZEF. The focus of the mechanization research cluster for 2018-2019 entails three working packages: (1) Institutional Options for Mechanization; (2) Skills development for mechanization, (3) Opinions and policy beliefs with regard to policy instruments and effects related to mechanization, youth and digitalization.

The mechanization research cluster commenced its activities with an inception meeting that was held at the conference room of KALRO in Nairobi. At the inception meeting, the methodology for the study was discussed and agreed; a field visit was also organized to pre-test the various instruments and adjustment were made accordingly. Afterwards the various countries embarked on the study. This report presents the update on the country implementation progress in a meeting held at the ARCN conference room in Abuja, 7-8 October 2019.

B. Workshop Proceedings

1. Opening

The Workshop was opened was opened by the Actin Executive Secretary of ARCN, Prof. Garuba Sharibity. In his opening remarks he emphasized the importance of agricultural mechanization in the crave to develop Nigeria agriculture. He referred to the various government initiatives in Nigeria and the key pitfalls observed over time. Nigeria government have established two research and development organizations dedicated to production of agricultural machineries they are National Centre for Agricultural Mechanization (NCAM), in Ilorin, Kwara state and The Federal Institute of Industrial Research (FIIRO) Oshodi, Lagos state. A lot of indigenous efforts are also going on to ensure the transformation of the smallholders' system. As part of the government support for mechanization, there is import exemption on agricultural machineries for farm and industries. This is to encourage the use of machines. The government at different levels also have various mechanization programs for tractorization and farm development. He acknowledges the appreciation of ARCN to the ZEF and BMZ for the good research partnership.

Other opening remarks from FARA delivered by Dr. Fatunbi, ZEF by Dr. Oliver Kirui and Hohenheim by Thomas.

C. Highlights of Presentation and Discussion

1. **Opening presentation (By Oliver Kirui)**
   - Provided an overview of PARI research agenda and questions. Agricultural growth has been from area growth rather than from innovation, PARI aims to identify prospective intervention that can trigger development from innovation. Central question is ***Which will be the most beneficial investment into innovations for agriculture & food system growth (and what kind of innovations will that be)?***
   - PARI strategy is to; (1) Assessing the potential and impact of **innovations; (2).** Improving the **framework conditions** for innovation and (3). Informing **evidence-based policy** to support reforms and investment decisions
   - The key research issues investigated by PARI research since 2017 include; Mechanization and related skill development, and Digitalization & ICT 4 Agric and food
   - Seed sector; Vocational training of youth; Crop Insurance; Farmer organizations; Solar energy in food and agriculture; Job creation in food system; Strategies for scaling innovations; Land use and water (incl. irrigation), Input and output markets, Approaches for disseminating and scaling farmer innovations, Automation in the food industry, Private sector investments in fertilizer and Digital finance technologies.

2. **Update Mechanization Cluster (Thomas)**.
   - Why focus on mechanization? Because of Changes in land and labor productivity. Recent reports has shown that Labor productivity grows with mechanization.
   - With mechanization in crop production, there is a relative decline in use of both tractor and animal traction, Tractors use per 1,000 ha: 2.0 in 1980 compared to 1.3 in 2003.
   - Trends and current status indicated a relative decline in the use of machineries in Africa countries.
   - Current indicators showed that , there are ample Neglected field from the 1990s onwards; there Lack of success of state-driven mechanization projects of the 1970s/1980s (Pingali et al., 1991), there is renewed interest in recent years and Strong interest by policy makers in Africa to overcome “hoe and cutlass” in order to make agriculture attractive for youth (Mockshell and Birner, 2015). There is also Interest by private sector (manufacturers of machinery), they have identified Africa as a major future market; there is rise of medium scale farmers (Jayne et al. , 2016).
   - Are there opportunities for change? Yes, there could be a reversion of the neglect in mechanization investments, should the policy makers have access to accurate information on the state of the sector.
   - In 2018/2019 four different studies were conducted:
     - a survey among tractor owners on state-led and market-led mechanization efforts
     - Participatory Impact Diagrams on the impacts of mechanization
     - a survey on skills development for mechanization among training institutes
     - a survey on opinions and policy beliefs about policy instruments and effects related to mechanization, youth and digitalization (links to other research clusters)

3. Outcome of Kenya research

Tractor survey: The study covered seven county's that are mechanized, it also looked at four key value chains. The sample size 206 comprising of 187 private and 19 public), total response rate was 69%. The data collection use focus group discussion and key informant discussion.

- The private sector is the key mode of acquisition of tractors in Kenya
  There are many well established private dealers (Massey Fergusson, Hughes Ltd (Ford), FMD, John Deere, New Holland, Japan's Kubota, Case etc.)
  There is a thriving market for second-hand tractors (dealer to farmer / Farmer to Farmer)
- **Public-led Initiatives (National and Government) have also contributed**
  2KR Project (JICA and Government of Kenya) since 2013
  The More Food (Mais Alimentos) program supported by the Brazilian Government,
  Farm Mechanization and Conservation Agriculture for Sustainable Intensification (FACASI) project
  Direct Purchases by various County Governments
  The project Line of Credit of USD 100 Million (Kshs.10 billion) signed between Government of Kenya and Exim Bank of India – In the pipeline
- The public led acquisition of tractor services are less efficient, for bureaucracies and other bottle neck associated with the public system. The key maintenance problems include the Hydraulic systems etc.
- Reason why people buy tractors., this largely to scale up farm operations, to farm timely and to run a tractor hiring business.

Knowledge and Skill development for mechanization

All the institutions interviewed offered **long and short term courses** which comprised theoretical and hands-on training.

- State owned Universities e.g. University of Nairobi, Egerton University, and Jomo Kenyatta University of Agriculture and Technology with agricultural engineering departments are involved in research as well as testing and fabrication of agricultural machinery (Wawire et al., 2016).
- Agricultural mechnainsation was offered as a course / unit within the program of Agricultural Engineering at University level.
- At TVET level, Agricultural Mechanization was offered either as a diploma or certificate course or as a unit in General Agriculture
- Unversity leve courses took 4 years; Diploma- 3 years; Certificate – 2 years to complete

- **Desired Curriculum (content) change** in training for both Dip in agric. Engineering and general Agriculture
  - More hands on or practical sessions
  - More internships
  - *More linkage with industry*
- Student fees were the main source of funding for the TVET institutions followed by government and donors/private sector, respectively.
- The main challenge was inadequate facilities. Nonetheless, TVETs were better equiped compared to universities.
- The types of linkages
  - Industry & NGOs providing students to training institutions (training / attachment)

- Industry providing internship opportunities for the university students.
- NGOs providing financial assistance / scholarships to needy students

4. Outcome of Benin research

Tractor Survey results

Contraints to growth in mechanization

- Poor skill by technicians,
- Price and unavailability of original spare parts,
- High cost of the machine / accessories,
- Inability to meet producer's preference
- Lack of opportunity to share experiences with producer & frequent support of extension agents
- Lack of after-sales services
- Involvement of mechanics in scientific research on agricultural machinery
- Development of spare parts stores
- Access to agricultural credits

State of Skills development for Mechanization

- Many types of institutions provide training in mechanization sector
- The number of lecturers is low in the public institutions (agricultural school).

Key programs include,

- manufacture of agricultural equipment,
- agricultural machinery,
- maintenance of agricultural machinery,
- agricultural equipment, and rural engineering and agricultural mechanization.

Opinion and beliefs on agricultural mechanization policies in Benin

- A majority of experts from organizations were male. Most of them have a high university degree (PhD, Master),
- Most of the agricultural expenditure is allocated to extension and mentoring programs.
- Few expenditures are allocated to youth, ICT in agriculture, agricultural mechanization, and agricultural inputs programs.
- All organizations support the mechanization agricultural, if provisions are taken to mitigate the negative effects.
- They show that human strength is not enough to guarantee good productivity

Participatory Impact Diagram of agricultural mechanization in Benin

Positive Impact: The introduction of the tractor brought to a considerable reduction in the working time allocated to farming operations. Men and women show that this saving of time is generally used to rest, develop leisure activities, extra-agricultural activities (trade, crafts, etc.), and diversify the crops produced. The available rest time also allows them to allocate more time to the side of their families, to discuss with their spouses, their children, and involve them in the decision making, and plan possible projects. This involve a positive impact on the level of entrepreneurship of men, especially women, and young people. All men and women of PDA, on the one hand, show that the availability of rest periods

has also favored the reduction of the frequency of diseases mainly at the level of men in their community. On the other hand, they show that the diversification of extra-agricultural activities improves their income, and prosperity level. This allows them to improve their living conditions, to enjoy a better social reputation in the community and to have access to information (purchase of television set, radio, etc.). This change had occurred at the level of men, women, and children. Improving the level of prosperity is also noticeable on indicators such as birth rate, farm assets, school enrollment, death rate, and even agricultural production.

Negative Impact: Beyond these positive impacts, some negative impacts inherent to the introduction of the tractor have been identified. In order to intensify agricultural activities with the tractor, the farmer clear out the forest, this practice seems to favor the advancement of the desert (desertification). This negative impact was declared by the majority of men (92%), and women (94.5%) at all PDA levels. On the one hand, they show that deforestation also leads to soil erosion and climate change. These affects soil fertility, yield and agricultural production.
On the other hand, the increase in plantings creates new requirements in terms of expensive stump removal operations and maintenance services (maintenance, etc.) that increase operating costs. To meet these requirements, more than 67% of men and women show that some producers sell their animals (livestock, etc.) to carry out this land preparation activity. This implies a reduction in the size of the herd, and further favors the indebtedness, and other social risks.

5. Outcome Nigeria research

Institutional options for mechanization, including state-led procurement and distribution of machinery and private sector activities.

- Nigeria's agricultural mechanization technology has continued to be import oriented.
- There are many vendors of tractor and machineries in Nigeria. Prominent vendors in Nigeria include
- SCOA, Springfield Agro, Pan African Equipment Nigeria Limited, Dizengoff Nigeria Limited and TATA Africa Services (Nigeria) Limited. Springfield Agro (Mahindra), TATA (John Deere), SCOA (New Holland), Dizengoff Nigeria Limited (Massey Ferguson), Pan African Equipment Nigeria Limited (Valtra).

There are 2 major associations which provide tractor hiring services in Nigeria.

- i)The Tractor Owners and Operators Association of Nigeria (TOOAN) and
- ii) Tractor Owners and Hiring Facilities Association of Nigeria (TOHFAN)

Kinds of Tractor hiring services in Nigeria

- Owner as operator: Few cases exist where tractor owners doubles up as the operator. In such cases however, assistant operators are usually on stand-by in case the owner is not disposed.
- Owner rents the tractor to the operator and operator provides the service to the farmers: - absentee owners who are not involved directly involved in the management
- operator takes all responsibilities about the tractor except for major repairs which is transferred to the owner.
- part-time basis, since they have their major occupations such as being a civil servant, or they are engaged in other business, which provide the bulk of their annual income.
- In most cases, these types of owners get their tractor from Government sources at a subsidized price.
- Owner hires the operator and pays him from the income from the farmers: Majority of tractor owners interviewed

Government Tractor Provision program

1. the community cooperative Tractor Hiring Scheme (Tractorization Programme) through the Public Private Partnership Model to make available 1,950 units of various Tractors and Implements (FGN, 2008).
2. Kaduna State Ministry of Agriculture (KSMOA)
3. does not provide tractor hiring services.
4. Niger State
5. Niger State Rice Investment Consortium (NSRIC) is a complete rice value chain solution in Niger State**.**

Policy debate on state led to market led mechanization

- The level of involvement of government in the provision of efficient mechanization
- production, sales, importation of farm tools and equipment, the private sector for years has been discouraged.
- The involvement of private sector (Farmers, Retailers and Wholesalers, Manufacturers, and Importers.)
- A fundamental requirement is that mechanization business as performed by each category of the private sector must be profitable. If farmers are not making money, they will not be able to purchase inputs; etc.
- Absence of a thriving agricultural machine and tool manufacturing, importing, and retailing sub-sector can often be traced to the lack of profitability in one of these groups.
- Creation of the linkages between each group and the addressing of issues which affects the profitability of one or more of these groups (Clarke, 2000).

Knowledge of Machines

- Status of machine knowledge is limited among users in Nigeria.
- Disparity associated to the volume of tractors available in Kaduna state and mechanization organizations present in Kaduna state were more than Niger and Oyo state.
- Mechanization and tractor operations in Niger and Oyo state were observed to be privately driven, mostly, one-man business. Such businesses are carefully managed and details are paid
- . The first three major constraints faced by tractor owners in the study area were
    - high costs of tractor attachments
    - Prevalence of fake and substandard spare parts.
    - Operation knowledge, an indicator of the tractor operator's technical skills
    - Low demand for the services of tractor owners in the study area was generally low.
    - Non-availability of credit facilities
    - zero activities during the off-season period

To Assess opinions and policy beliefs with regard to policy instruments and effects related to mechanization, youth and digitalization

- Majority (80%) of the respondents have positive and supportive attitude towards agricultural mechanization in Nigeria
- Higher mean preference of allocation in favor of mechanical traction
- Agricultural mechanization, input, are critical to agricultural growth in Nigeria.
- Agricultural mechanization should a key strategy to attract youth to agriculture. Nigerian youth.
- Emphasis on ICT applications.
- Cooperative societies as vehicle for the promotion of smallholder mechanization in Nigeria.

Participatory Impact Diagram of agricultural mechanization

Benefits

- to increase in productivity
- increase in income
- tractor utilization brings about reduction in drudgery at 98%, 96% and 100% in Oyo, Niger and Kaduna states respectively.

Limitation

- Difficulty in timely accessing/ engaging a tractor to undertake a particular activity.
- Closeness to source of diesel for tractors

The PID revealed that tractor mechanization is a development that enhances agricultural productivity, increases income and encourages adoption of good Agricultural Practices (GAP). Planter = yields
Despite some challenges and limitations attached, respondents agree to use tractor mechanization over their old ways of animal drawn implements and hoes and cutlasses

To Assess the effects of agricultural mechanization on rural communities.

- Successful mechanization requires the provision of both theoretical knowledge (e.g. significance of maintenance) and practical skill (e.g. how to do maintenance well.
- Untrained operators are neither aware of the need for regular services nor possess the skills to do this properly.
- Basic knowledge about agricultural mechanization is undertaken by the universities, polytechnics and specialized colleges and institutions.
- Mechanical, civil and chemical engineering was the most sought courses (by males) in the engineering field.
- Female applicants prefer chemical, civil and agric bio-environmental engineering.
- More than 82% of male applicants were enrolled for mechanical engineering, while over 88% of female applicant were enrolled for chemical engineering.

Recommendations

1. **Need for Mechanization Planning**
   - Below par performance and low contribution of mechanization to agricultural development in Nigeria
   - Poor planning by government agencies and overreliance on
   - Unpredictable or unsuitable, one-off aid-in-kind or other external mechanization inputs.
   - Lack of teamwork or coordination within and between governments
2. **Need for structural and institutional Changes**
   - Structures of landholding and land ownership: options to be put in place to reduce further fragmentation of farms.
   - Education and training: Training is necessary not only for farming skills but also for management of farm machinery
   - Credible & training schemes are necessary for Operators and machine owners
3. **Building partnership**
   - A broad partnership is required between the public-sector and private-sector agencies and actors. Governments should be encouraged to facilitate and support such initiatives.
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   - Government role in development and maintaining standards.

- private sector is better equipped to look after the day-to-day provision of farm inputs including farm machinery and the associated vital machinery support services

6. Outcome Mali research

Institutional options for mechanization, including state-led procurement and distribution of machinery and private sector activities.

Machine utilization in Mali

- Machines (tractors) are mostly used for plowing (89.1% and 93.9%)
- own farm (79.3% and 85.7%)
- government program owners worked on 81.7 ha and private owners on 89.7 ha.
- The service charge is the same for both types of owners (20000 - 30000 CFA/ha for 2-3 hours)

Additional service

- Government-led owners are getting financial resource, while for private-led are to finance other activities
- For both: customers who arrived first are served
- Face competitors: from other areas or public services
- The operator is Son of owner or other member of the family
- Operators are controlled by owner or parent of owner

Knowledge of machineries

- Tractor owners have little knowledge on machinery
- 50% and 38% have very limited knowledge on cooling system; lubrification system, 46.6% and 32%; fuel system 46.6% and 34%; electricity system 69.8% and 57.1%
- The difference between government program and privately purchased owners is significative only for hydraulic, driving and machinery economics

Constraints

- technician availability
- lack of genuine spare
- price/unavailability of spare parts
- machine/attachment are too expensive

Effects of agricultural mechanization on rural communities.

Benefits

- Additional source of income;
- Improvement of social relations;
- Improvement of social status oft he owner in the community;
- Timely execution of farm works
- Quick crop installation for the cropping season ;
- Reduction of farm work drugery;
- Increase in arrable land;
- Reduced time for land preparation
- Timely land preparation;
- Reduction of farm drugeries;
- Yield and income increase.

Constraints

- Frequent break-downs and High fixing cost;
- Difficulties to follow-up the machine;
- Lack of specialized operators and mechanics
- Improper use could lead to degradation of soil in Sahelian zones;
- -Cost of service very high for poor farmers;
- High service cost and queuing for service;

Day two

Day two featured two presentation and discussions on the Publication idea for the research conducted so far and development of research idea for the next phase.

1. **Study presentation**
   Agricultural mechanization in Africa: micro-level analysis of state, drivers, and effects by Olive Kirui.

   The objective of the study: was to examine the state, drivers and, consequently, the impacts of agricultural mechanization in 11 countries in Africa

   Key outcomes:

   - Light hand-held machinery still predominant means of land preparation. But tractor-powered mechanization is largely common in Egypt (90%) and South Africa (72%)
   - A few households hire (rent) tractors, ploughs, and threshers
   - To developing lease arrangements that favor small holder farmers would be desirable
   - Many variables showed significant but mixed evidence in determine use of APM & TPM *(e.g. land tenure, type of farming system, irrigation, number of household and hired laborers)*
   - This calls for country specific studies and tailored policies (consider local conditions and realities to increase uptake of farm mechanization)
   - Agricultural mechanization significantly increases the amount of cropland cultivated and is accompanied by input intensification in majority of the countries
   - The mixed evidence on displacement or increased use of family and hired labor. Thus, there is need for national rather than regional assessments to better inform policy.
   - These findings point to the importance of developing favorable arrangements that would avail mechanization to small and medium scale farmers either through AP or TP

2. Publication ideals from the research conducted so far.

a. Market vs. state-led mechanization: Comparison of maintenance, tractor status and lifetime, owners, service provision
b. Participatory Impact Diagrams: What are the impacts in different countries (agro-ecological zones)? For different gender?
c. Policy Beliefs: What do different types of stakeholder think about different impacts and policies?
d. Knowledge and Skills: What are the effects of training and maintenance of tractor status, breakdowns, profitability?
e. State of Ag. Knowledge and Skills Institutions
f. Factors driving service provision for smallholder farmers

4. The Next phase of PARI; the following research issues are proposed.

a. Mechanization need for post-harvest processing etc.
b. The scope, effectiveness and continuous relevance of informal training for tractor operators and mechanics.
c. Appropriate machineries for agricultural domains (agroecology, soil types etc.)
d. Mechanization with Animal traction versus Animal right in Africa.
e. Cost efficiency in mechanization along the value chain: imperative for use of solar energy in food processing.
f. Mechanization along the water and irrigation systems.

D. Agreed Action

Country Partners:

1. KALRO, ARCN, IER and INRAB will finalize the study reports and produce specific policy papers.
2. Country partners will share the raw data for further processing.

ZEF and Hohenheim university:

1. Lead the preparation of the six vital papers to be published as journal articles.

FARA

1. Prepare (peer review, editing) and publish the country reports in high quality format.

Annex 1: List of Participants

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Annex 2: Workshop Program

Agenda for PARI Workshop PARI in Nigeria, September 27/28th 2019

During the last decade, agricultural mechanization has re-emerged as a priority on the development agenda of Africa. To scientifically support these mechanization efforts, one of PARI's research clusters conducts different studies on agricultural mechanization. The research is led by FARA, the Center of Development Research (ZEF) and the University of Hohenheim and conducted by the Institut National des Recherches Agricoles du Bénin (INRAB), Kenya Agricultural and Livestock Research Organization (KALRO), Agricultural Research Council of Nigeria (ARCN) and Malian Institut d'Economie Rurale (IER). In 2018/2019 four different studies were conducted by these country partners: 1) a survey among tractor owners on state-led and market-led mechanization efforts; 2) Participatory Impact Diagrams on the impacts of mechanization; 3) a survey on skills development for mechanization among training institutes; and 4) a survey on opinions and policy beliefs with regard to policy instruments and effects related to mechanization, youth and digitalization.

In the PARI cluster workshop, the results from these studies are to be presented by each of the partner countries and discussed. General lessons learnt from the four country studies will be distilled and a synthesis will be presented by the Center of Development Research (ZEF) and the University of Hohenheim. It will also be discussed on how to best share the results with policymakers. The Center of Development Research (ZEF) and the University of Hohenheim will present additional work from studies on mechanization done by them. Given a potential extension of PARI, the way forward will be discussed, pending on the progress so far.

Friday 27th September

Venue: ARCN, Abuja

Opening session and country presentations	
09:00 – 09.30	***Introduction and Update*** ▪ *Introduction of participants and aim of workshop*
09.30 – 11:00 *(incl. coffee & tea)*	***Country presentation Kenia*** ▪ *Survey among owners of publically and privately imported machinery* ▪ *Survey and knowledge and skills development for mechanization* ▪ *Survey on opinions and policy beliefs with regard to policy instruments and effects related to mechanization, youth and digitalization* ▪ *Participatory Impact Diagrams to assess the positive and negative impact of agricultural mechanization*
11:00 – 12:30	***Country presentation Benin*** ▪ *Survey among owners of publically and privately imported machinery* ▪ *Survey and knowledge and skills development for mechanization*

	▪ *Survey on opinions and policy beliefs with regard to policy instruments and effects related to mechanization, youth and digitalization* ▪ *Participatory Impact Diagrams to assess the positive and negative impact of agricultural mechanization*
12:30 – 14:00	***Lunch Break***
14:00 – 15:30 *(incl. coffee & tea)*	***Country presentation Mali*** ▪ *Survey among owners of publically and privately imported machinery* ▪ *Survey and knowledge and skills development for mechanization* ▪ *Survey on opinions and policy beliefs with regard to policy instruments and effects related to mechanization, youth and digitalization* ▪ *Participatory Impact Diagrams to assess the positive and negative impact of agricultural mechanization*